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I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003901207 for a patent by OUTOKUMPU OYJ as filed on 17 March 2003.

WITNESS my hand this
Thirtieth day of March 2004

J. Billingsley

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AUSTRALIA

PATENTS ACT 1990

PROVISIONAL SPECIFICATION

FOR THE INVENTION ENTITLED:-

"AUXILIARY AGITATOR FOR A FLOTATION DEVICE"

The invention is described in the following statement:-

TITLE: AUXILIARY AGITATOR FOR A FLOTATION DEVICE

FIELD OF THE INVENTION

The present invention relates to flotation devices of the type used in mineral separation and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

BACKGROUND OF THE INVENTION

The following discussion of the prior art is provided to enable the invention to be placed in an appropriate technical context, and to facilitate an appreciation of the advantages that flow from it. However, references to prior art should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Conventional flotation devices typically include a tank to receive and contain slurry from a grinding mill, a cyclone separator, or the like. An agitator, comprising a rotor housed within a stator, is normally disposed within the tank to agitate the slurry. An aeration system is also provided to direct air under pressure into the agitator through a central conduit formed within the drive shaft. Suitable reagents are also added, which coat the surfaces of the mineral particles within the slurry to make the particles hydrophobic so as to preferentially promote bubble to particle attachment. As bubbles dispersed by the rotor rise toward the surface of the tank, they carry with them floatable valuable mineral particles, which form a mineral enriched surface froth. The froth then migrates over a lip and into a launder whereby the valuable mineral particles suspended in the froth are recovered from the tank as a mineral concentrate. The gangue particles remaining suspended in the slurry, along with those mineral particles not removed by flotation, are discharged from the tank through a bottom outlet. The bottom outlet often incorporates a dart or pinch valve, which is opened to allow the remaining slurry to progress under gravity feed to downstream treatment processes. An automatic control system, typically incorporating a liquid level sensor and a PID controller, regulates a control valve to maintain a substantially constant liquid level in the tank.

The rotor disclosed in US4,078,026 is an example of a rotor that is used in prior art devices in this field.

As flotation devices increase in size, the agitation input energy must increase proportionally. Moreover, for a large flotation device to maintain efficiency, it must be

capable of achieving a similar flotation kinetic rate as that achieved by a group of smaller cells of the same total volume.

In recent years, the size of flotation devices has increased, primarily for economic reasons. However, the design of such devices has remained relatively unchanged. Accordingly, for the reasons mentioned above, these large flotation devices are often not optimised in terms of flotation efficiency.

It is therefore an object of the present invention to overcome or substantially ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

SUMMARY OF THE INVENTION

Accordingly, a first aspect of the invention provides an auxiliary agitator for a flotation device of the type having a tank, a primary agitator including a primary rotor, drive means, and a drive shaft disposed intermediate the drive means and the primary rotor, the auxiliary agitator including:

an auxiliary agitation blade; and

connecting means for connecting the blade to the drive shaft intermediate the drive means and the primary rotor.

Preferably, the angle of incidence is constant along the length of the blade as in an axial impeller, at between 15 degrees and around 75 degrees with respect to the direction of travel of the blade. Alternatively, the angle of incidence varies along the length of the blade as in a propeller. In another embodiment, the pitch of the blade is adjustable depending on specific system parameters, such as slurry density, slurry viscosity or flow characteristics within the tank.

Preferably, the blade includes a substantially straight leading edge. However, in alternative embodiments, the leading edge may be curved.

Preferably, the blade is releasably connected to the shaft to allow its position along the shaft to be adjusted. However, the blade is preferably connected to the shaft at around the midheight of the tank.

Preferably, the connecting means include a clamp. More preferably, the clamp is formed of two inter-engageable clamping halves. More preferably, the two clamping halves are substantially identical. Even more preferably, inner walls of the clamp

together define a generally cylindrical clamping surface. Alternatively, the connecting means take the form of welds or bolts.

Preferably, the agitator includes a resilient protective layer coating its exterior surfaces. More preferably, the layer is greater than 3mm thick. Even more preferably, the layer is between around 5mm and around 7mm thick.

Preferably, the agitator includes a pair of the auxiliary blades, in use extending radially outwardly from diametrically opposite sides of the shaft, each blade having associated connecting means. Alternatively, the agitator includes at least three of the blades, in use equally spaced around the perimeter of the shaft, each blade having associated connecting means.

Preferably, in use, each blade intersects the shaft at an angle of incidence of around 45 degrees.

According to a second aspect, the invention provides agitation means for a flotation device of the type previously defined, said agitation means including:

a drive shaft;

a primary rotor connected to one end of the drive shaft to form the primary agitator; and

an auxiliary agitator as defined above.

Preferably, the agitation blade is releasably connected to the shaft to allow its position along the shaft to be adjusted. However, the blade is preferably located substantially at the midpoint of the drive shaft.

Preferably, the agitation means are suitable for use in a three phase environment including water, solids and air.

According to a third aspect, the invention provides a flotation device including:

a tank for containing slurry incorporating minerals to be extracted;

a feed inlet for admission of slurry into the tank;

agitation means, as defined above, to agitate the slurry within the tank; and

aeration means to aerate the slurry whereby floatable minerals in suspension form a surface froth.

Preferably, a stator surrounds the rotor.

Preferably, a peripheral overflow launder extends around the inside top of the tank for recovering mineral enriched froth from the surface.

Preferably, the aeration means include an air blower and a fluid conduit for directing air from the blower into the rotor. More preferably, the conduit includes an axial bore extending through the drive shaft. Alternatively, the conduit is disposed to direct air into the rotor from underneath.

Preferably, the flotation device includes a froth deflection cone extending around the drive shaft adjacent the top of the tank, the smallest diameter of the cone being at its lowermost end nearest the rotor. More preferably, the deflection cone is disposed to deflect froth outwardly toward the overflow launder as it migrates toward the surface of the tank. Even more preferably, the deflection cone is disposed to prevent vortexing at the tank surface.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of agitation means according to the invention;

Figure 2 is a side view of the agitation means of Figure 1;

Figure 3 is a top view of an auxiliary agitator according to the invention; and

Figure 4 is a sectional side view of a typical flotation device incorporating the agitation means.

PREFERRED EMBODIMENTS OF THE INVENTION

Referring to the drawings, the agitation means 1 include a primary rotor 2 connected to one end of a drive shaft 3. The primary rotor is configured for use as the primary agitator in a flotation device. The other end of the drive shaft is supported by a mounting flange 4 and adapted for connection to an associated motor and gearbox (not shown), via a belt drive assembly, or other suitable drive means. A froth deflection cone 5 extends around the drive shaft adjacent the top of the tank. The deflection cone is oriented such that its smallest diameter is located at its lowermost end nearest the rotor 2.

An auxiliary agitator 6 is connected to the drive shaft at a position substantially midway between the underside of the deflection cone 5 and the top of the rotor 2, as shown in Figure 1 and Figure 2. The auxiliary agitator 6 includes agitation blades 7 extending radially outwardly from diametrically opposite sides of the shaft 3. Each

blade 7 intersects the shaft at an angle of incidence of around 45 degrees to the shaft axis 8.

The blades 7 are connected to the shaft 3 by a clamp 9. The clamp is formed from two clamping halves 10 and 11 secured together by bolts 12 and each including one blade 7. The inner walls of the clamp define a cylindrical clamping surface 13.

A 6mm rubber coating 14 is provided on the outer surfaces of the auxiliary agitator to protect it from chemical and mechanical abrasion.

The agitation mechanism 1 is designed for use in a known flotation device of the type illustrated in Figure 4. The flotation device includes a tank 15 to receive and contain a slurry containing ore particles from a grinding mill. A peripheral overflow launder 16 extends around the inside top perimeter of the tank for recovering mineral enriched froth as it floats to the surface. An aeration system including an air blower and a fluid conduit (not shown) is also provided to direct air from the blower into the rotor 2. The conduit is defined in part by an axial bore (not shown) extending through the rotor drive shaft 3. The flotation device also includes a stator 17 surrounding the primary rotor.

In use, the rotor 2 induces a primary flow through the slurry as indicated by arrows F1. The primary flow continuously recirculates the slurry at the bottom of the tank 15 to maintain the particles in suspension. The aeration system continuously disperses air into the rotor to form fine bubbles which collide with and adhere to the valuable mineral particles in the slurry and subsequently float to the top of the tank to form a mineral enriched surface froth. As the froth floats toward the surface, it is directed radially outwardly by the deflection cone 5 for recovery through the overflow launder 16.

The primary rotor also induces a secondary flow through the slurry as indicated by arrows F2. However, as flotation devices increase in size, the secondary flow induced by the primary rotor reduces. Accordingly, it has been found that when floatable particles drop out of the froth zone at the tank surface, the secondary flow induced by the primary rotor alone is often not sufficient to draw these particles back into the mixing zone of primary rotor for refloating, thereby reducing the cell efficiency. This problem is particularly relevant in flotation devices of capacity greater than around $150m^3$ to $200m^3$ or larger.

The auxiliary agitator increases the secondary flow in large flotation devices to an extent comparable to that of a group of smaller cells of equivalent total volume. It

achieves this by inducing a downward current, which increases the secondary flow turnover rate. This, in turn, draws floatable particles that have dropped out of the froth zone down through the tank and into the mixing zone of the primary rotor, thereby increasing the probability that these particles will be refloated, and hence increasing the overall efficiency of the recovery process. In addition, the auxiliary rotor also facilitates dispersion of reagents added to the slurry through a reagent addition tube 18 extending downwardly through the deflection cone. It will be appreciated that the invention thereby provides both practical and commercially significant advantages over the prior art.

It will be appreciated that in other embodiments many components of the flotation device described above may be substituted with suitable alternatives. For example, the auxiliary agitator can be connected to the drive shaft by other means, such as welds or bolts. Also, the coating provided on the outer surfaces of the auxiliary agitator may be formed from an alternative material such as polyethylene and may also be of a different thickness. In one embodiment, the auxiliary agitator includes a curved leading edge, similar that on a propeller. The auxiliary agitator can also be shaped to have a variable angle of incidence along its length.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

DATED this 17th Day of March, 2003
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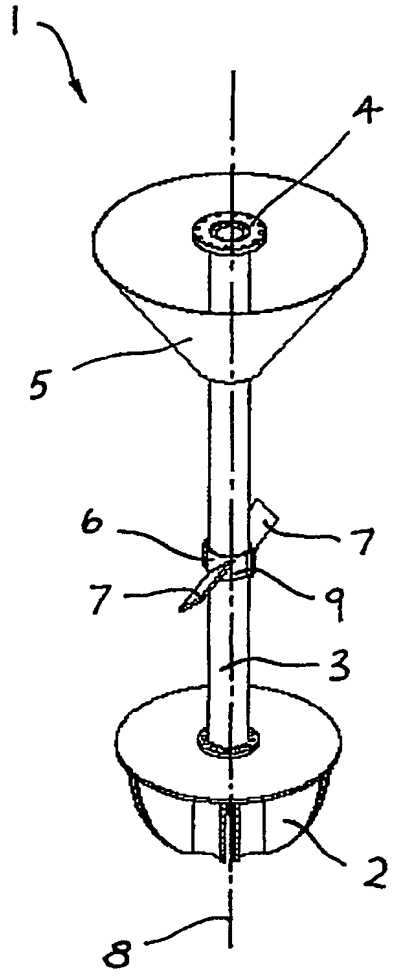

FIGURE 1

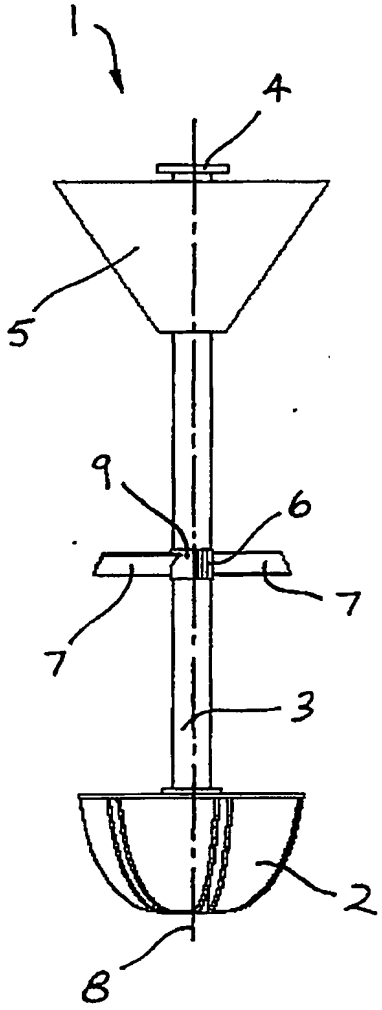

FIGURE 2

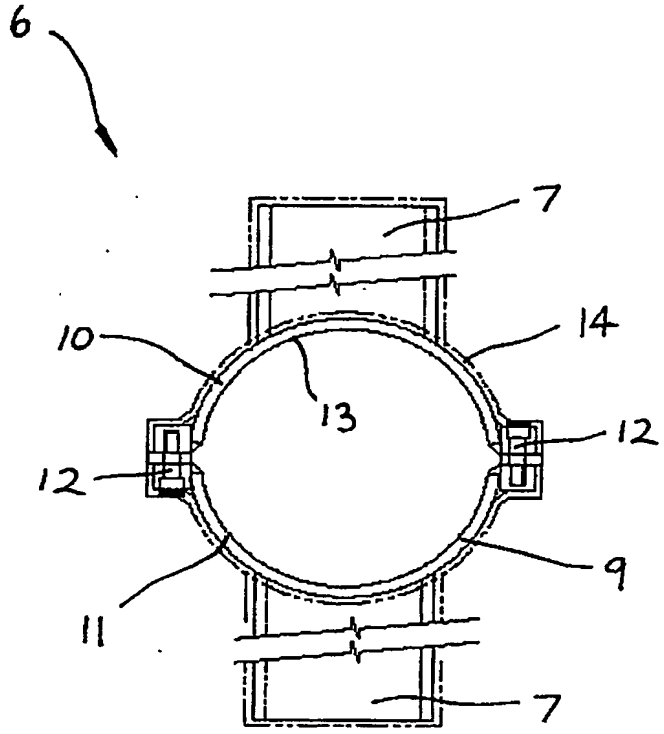

FIGURE 3

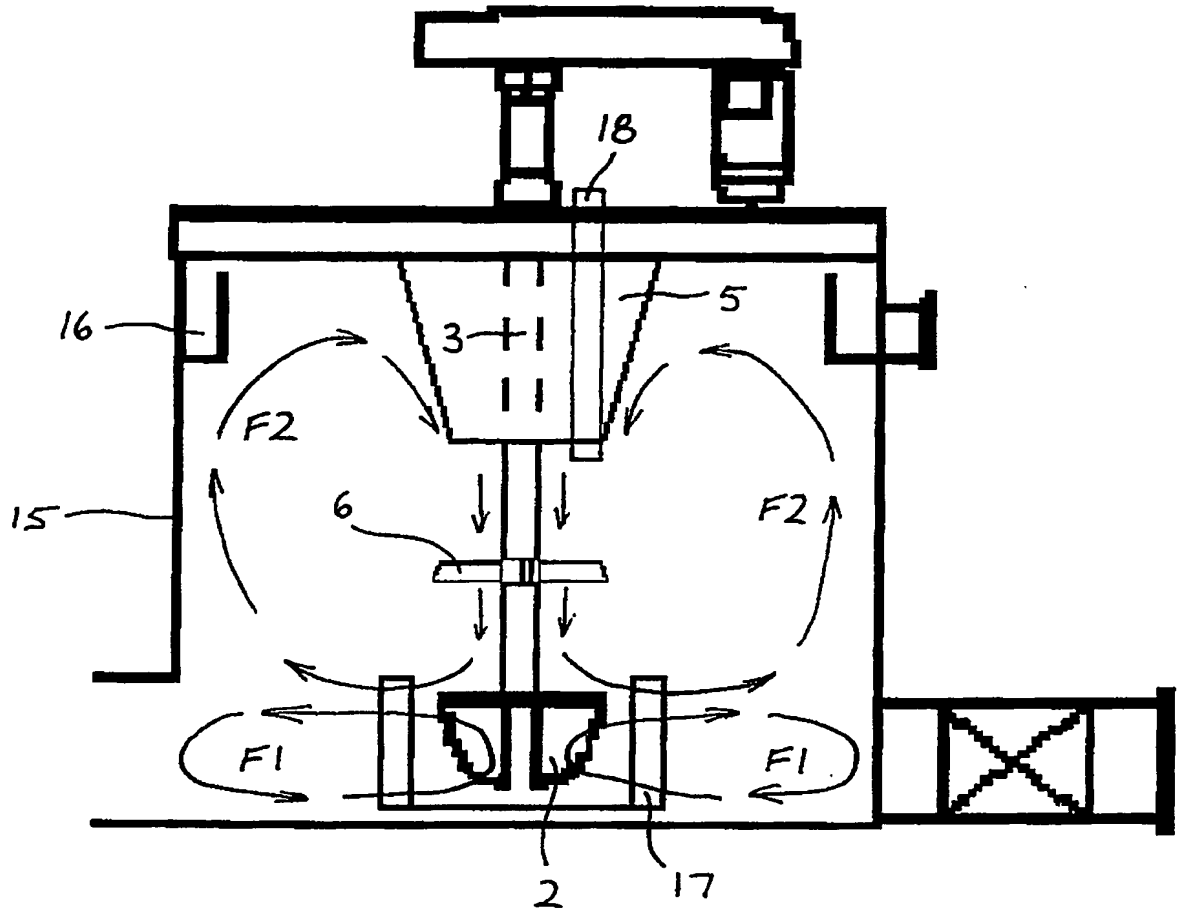

FIGURE 4